



Law, J., Rush, R., Clegg, J., Peters, T., & Roulstone, S. (2015). The role of pragmatics in mediating the relationship between social disadvantage and adolescent behavior. *Journal of Developmental and Behavioral Pediatrics*, 36(5), 389-398.
<https://doi.org/10.1097/DBP.0000000000000180>

Peer reviewed version

Link to published version (if available):
[10.1097/DBP.0000000000000180](https://doi.org/10.1097/DBP.0000000000000180)

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The role of pragmatics in mediating the relationship between social disadvantage and adolescent behaviour

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Conflict of interest: The authors declare no conflicts of interest

Financial disclosure: The study was funded by the Department for Education in England

ACKNOWLEDGEMENTS

We are grateful to all the families who have taken part in the ALSPAC study, the midwives for their help in recruiting them, and the whole ALSPAC team, which includes interviewers, computer and laboratory technicians, clerical workers, research scientists, volunteers, managers, receptionists and nurses. We would like to thank the ALSPAC speech team who collected the speech and language data and to Laura Miller who has acted as our “data-buddy” throughout this project, providing the dataset promptly and answering our various queries about the variables and coding.

The UK Medical Research Council, the Wellcome Trust and the University of Bristol provide core support for ALSPAC. The research presented here was funded by the Department for Education in England DFE-134

ABSTRACT

Objective

The relationship between social disadvantage, behaviour and communication in childhood is well established but we know less about how these three interact across childhood, and specifically whether pragmatic language skills act as a mediator between early social disadvantage and adolescent behaviour.

Method

The sample was the Avon Longitudinal Study of Parents and Children (ALSPAC), a representative birth cohort initially recruited in England in 1991/92 and followed through to adolescence and beyond. Of the original 13992 live births data were available for 2926 children at 13 years. Univariable analysis was first used to identify socio-demographic and other predictors of the Strengths and Difficulties Questionnaire (SDQ) at 13 years. We then tested the mediational role of the pragmatics scale of the Children's Communication Checklist (CCC) at 9 years, controlling for age, gender and IQ.

Results

There was evidence of both a direct effect from Social Disadvantage (path C') to SDQ Total Behaviour Score at 13 years (-0.205; $p < 0.001$) and an indirect effect from Social Disadvantage to SDQ Total (-0.225; $p < 0.001$) after adjusting for the CCC pragmatics scale as a mediator. The latter represents a reduction in the magnitude of the unadjusted effect or 'total' effect' (-0.430), demonstrating that the pragmatics scale partially mediates the relationship of early social disadvantage and adolescent behaviour (even after controlling for other covariates). The same relationship held for all but the Pro-social subscale of the SDQ.

Conclusion

The results provide evidence to suggest that there may be a causal relationship between these variables suggesting that interventions targeting pragmatic skills have the potential to reduce adolescent behavioural symptoms.

Key words

Cohort study, mediation, social disadvantage, behaviour, pragmatic language

Abbreviations

ALSPAC: Avon Longitudinal Study of Parents and Children; CCC: Children's Communication Checklist; SDQ: Strengths and Difficulties Questionnaire; WISC: Wechsler Intelligence Scale for Children

BACKGROUND

While the association between social disadvantage and behaviour in childhood and adolescence is well recognised (1), the nature of that relationship still remains unclear. It has been suggested that social disadvantage predicts psychopathology largely by virtue of its impact on development more generally (2). One aspect of development that has attracted considerable attention recently is the role played by the child's communication skills. The overlap between such skills and behaviour in the early years is well documented, irrespective of how the children are identified (3, 4). Understandably, given the highly contextualised nature of both behaviour and communication, these skills are closely associated with social disadvantage (5, 6). Indeed it has been suggested that the association of the two in the context of social disadvantage almost certainly exacerbates the long-term implications for the children concerned (7,8).

In earlier studies, the association between language and behaviour was reported to be stronger if the child had expressive/ receptive difficulties rather than isolated speech or expressive language difficulties (8). More recently, however, the suggestion has been made that "higher order" or pragmatic language difficulties which are associated with the child's ability to interpret effectively the intended meaning of others may be particularly relevant to the perception of a child's behaviour. Thus pragmatic skills have been shown to be particularly relevant for children with Autism Spectrum Disorder SD (10) those referred to psychiatric services (11) and especially for children with conduct disorders (12), those identified with attention deficit hyperactivity disorder (13) and those with reactive attachment disorder (14). For example, in one community sample of 1364 children aged 4 years, pragmatic competence, but interestingly not structural language problems, was found to be highly correlated with behavioural problems of an externalizing nature, specifically hyperactivity (15). There have also been indications that the patterns of structural and pragmatic language difficulties may be a defining characteristic of the differences between children with Attention Deficit Hyperactivity Disorder (ADHD), ASD and SLI. (16) A recent paper on the changing nature of peer relations between 7 and 16 years of age in a group of children originally identified with specific language impairment (17) suggested that it was pragmatic skills which differentiated those children who were likely to go on to experience persistent peer problems. Nevertheless, the relationship

between social disadvantage and behaviour with pragmatic skills as a “third factor” has not been tested directly in older children. So it is appropriate, given the social salience of adolescent behaviour problems, to ask whether pragmatics plays a role in mediating the association between social disadvantage and adolescent behaviour. Such a mechanism is supported by clinical studies of children with specific language impairment (18,19) but studies are often quite limited in what they collect in terms of socio-demographic information. It has not been tested in large scale population samples primarily because such studies only very rarely collect data on pragmatic skills. Furthermore, most studies assess communication and behaviour at single time points, making it difficult to comment on the direction of the association.

While the Strengths and Difficulties Questionnaire (20) has become one of the most commonly used measures of behaviour, the assessment of pragmatics is much less well developed. Detailed observation of pragmatic skills has been possible for many years (21), but it is only with the development of the Children’s Communication Checklist that such data has been collected in populations samples (22,23) and that such analyses have become feasible. Only one study, The Avon Longitudinal Study of Parents and Children, has combined both these measures, the CCC in middle childhood and the SDQ in adolescence. In the present study we examine the role played by pragmatics in mediating the relationship between social disadvantage in early childhood and behaviour in adolescence, controlling for age, gender and both verbal and non-verbal performance.

METHODS

Participants

The study draws on data from the Avon Longitudinal Study of Parents and Children (ALSPAC), a prospective population-based cohort study of children born to mothers in the west of England between April 1991 and December 1992 with a resultant cohort of 13,992 live births (49.7% male).

Approximately 85% of all eligible mothers were recruited to the study (24, 25). Data are taken from questionnaires completed by the child’s parent and teacher and latterly the child themselves. The number of participants at a given time reflects response rates on specific measures. For the present analysis complete data were available on a minimum of 2915 children. Missing data were not imputed for the

purposes of the present analysis. The ALSPAC dataset includes a range of cognitive language and behavioural assessments and key to the present paper, is the only dataset to include data using the CCC at nine years and the SDQ at a number of different time points but of specific relevance here at 13 years.

Ethical approval

Ethical approval for the study was obtained at the inception of the cohort. All data were anonymised.

Analytical framework

Figure 1 provides a conceptual framework for the question that we are addressing. Language and behaviour are, of course, likely to be associated and we would also predict that non-verbal performance and gender are likely to influence that relationship. The role of pragmatics is, however, much less clear and the focus of this paper is on the potential mediating effects of this variable on the relationship between social disadvantage and behaviour. Autism is potentially of considerable influence in such an analysis and for this reason the results were checked for those with and those without an ASD diagnosis. The children with ASD were identified and all the analyses repeated with and without them being included to establish whether their presence made a difference to the conclusions drawn.

There are a number of approaches to assessing mediation. Baron and Kenny's approach has recently been developed using the Preacher and Hayes macro (26). This estimates the path regression coefficients in a mediator model and generates bootstrap confidence intervals (percentile, bias-corrected, and bias-corrected and accelerated) for total and specific indirect effects of the independent variable, X, on outcome, Y, through a mediator variable, M. Their method adjusts all paths for the potential influence of covariates not proposed to be mediators in the model and extends that of Baron and Kenny, with bootstrapping being one of the more highly recommended approaches for inference about indirect effects (27). Note that the steps are stated in terms of zero and nonzero coefficients, not in terms of statistical significance, as they were in the original Baron and Kenny (1986) paper.

Because trivially small coefficients can be statistically significant with large sample sizes and very large coefficients can be non-significant with small sample sizes, the steps should not be defined in terms of statistical significance. Statistical significance is informative, but other information should be

part of statistical decision making. For instance, consider the case in which path A is large and B is zero. In this case, $C = C'$. It is very possible that the statistical test of C' is not significant (due to the collinearity between X and M), whereas C is statistically significant. It would then appear that there is complete mediation when in fact there is no mediation at all.

Four steps allow us to test for mediation:

1. Establish that the explanatory variable of interest (Social Disadvantage) is associated with the outcome (SDQ Behaviour) after controlling for the covariates – that is, estimate and test path C in Figure 1.
2. Show that the key explanatory variable (Social Disadvantage) is associated with the potential mediator (Pragmatics) – that is, estimate and test path A in Figure 1.
3. Demonstrate that the potential mediator (Pragmatic Language) is associated with the outcome variable (SDQ Behaviour), after controlling for the key explanatory variables and the covariates (path B in Figure 1).
4. Establish the extent to which the potential mediator (Pragmatics) mediates the relationship between the explanatory (Social Disadvantage) and outcome (SDQ Behavior) variables; the extreme case of complete mediation would be reflected by a null relationship between these two variables after adjusting for the mediating variable and the covariates (that is, path C' in Figure 1 would be zero).

FIGURE 1 about here

If all four of these steps are satisfied, then the data are consistent with the hypothesis that the mediator either completely or partially mediates the relationship between the explanatory variable and the outcome. To summarise, path C represents the unadjusted (or “total”) effect of the explanatory variable of interest on the outcome, which comprises the “indirect effect” (path AB) and the “direct effect” (path C') of the explanatory variable on the outcome. The effect represented by C' is therefore the effect over and above that of the mediator (and covariates). Each of these three effects can be subjected to formal statistical hypothesis tests (28), and the extent of mediation is represented by the

magnitude of the indirect effect per se and (equivalently) by the degree of difference between the total and direct effects.

A series of univariable (29) regression models were initially employed to derive a final set of variables associated with SDQ Behaviour Total score and for each of the different subscales of the SDQ at 13 years. So as not to miss any potentially influential variables at an early stage, a threshold of $p < 0.100$ was used in these models. Since the outcome variable was continuous and the sample size was large, ordinary linear regression was used. All analyses were conducted in SPSS (version 19) and Stata (version 11).

Variables

We include the variables of gender (male 1; female 2) and age calculated at school entry. We also included birth weight (kg) split at 1.5kg as a proxy for early developmental risk (30). To assess social disadvantage we constructed a composite scale from questionnaire variables identified in the first year of life. We followed Schoon (31) in developing a broad measure of social disadvantage comprising six binary variables comparable although not identical to those used by Schoon and colleagues. These are Parental occupation (skilled vs unskilled), mother's education, (with or without O level [O levels being the national qualifications completed immediately prior to the end of compulsory schooling in the UK ie sixteen years of age at the time when the data were collected]), housing tenure (owner occupier vs not) overcrowding (with 1 person per room vs more than one person per room), receipt of state benefits (in financial hardship vs not) and car ownership (yes/no). The scale was scored out of a total of 6. In order to check whether children with and without Autism Spectrum Disorder (ASD) performed differently in our model we used an existing variable in the data set which corresponded to a clinical diagnosis (32). This involved combining health and educational data. Initially all children with developmental delay at any point during their childhood were identified; then all children having special educational needs from their health records were identified. These two lists were then matched to the ALSPAC data set. The medical records of those that were in all three were then scrutinised for a diagnosis of ASD made after a multidisciplinary assessment. A consultant paediatrician then went through the notes and confirmed that the children met ICD-10 criteria for ASD.

The outcome variable is the Strengths and Difficulties Questionnaire (SDQ) (20) a 25 item checklist of a child's behaviour with translations into over 40 languages. A teacher- or parent-rated measure, the SDQ provides a Total Difficulties Score, which is the sum of scores for the Emotional, Conduct, Hyperactivity and Peer Problems subscales. Each of the five scales of the SDQ are scored from 0-10, and one can add up four of these (emotional, conduct, hyperactivity and peer problems) to create a total difficulty score (range 0-40). There is also a score for the children's strengths – the Prosocial score – which, like the others, has a maximum score of 10 but works in reverse, with a high score indicating more pro-social behaviours. For each question the respondent is required to say whether a statement is "Not true", "Somewhat true" or "Certainly true". Both the total difficulties score and the individual subscale scores of the parent-rated version of the SDQ are used in the present analysis, completed when the children were aged 13 years. The internal consistency of the SDQ is relatively high (mean Cronbach's alpha: 0.73) as is the retest stability after 4-6 months (mean: 0.62) (16).

The mediator is the pragmatics composite of the first edition of the Children's Communication Checklist (CCC) (22) a parent and teacher report measure of a specific set of communicative behaviours. The Pragmatics Composite of the CCC is based on scales C to G of the CCC, namely: Inappropriate initiation (e.g. "Talks repetitively about things that no-one is interested in"); Coherence (e.g. "Would have difficulty in explaining to a younger child how to play a simple game such as 'snap'"); Stereotyped conversation (e.g. Make frequent use of expressions such as "by the way", "actually", "you know what?", "as a matter of fact", "well you know" and "of course"); Use of conversational context (e.g. tends to repeat back what others have just said); and Conversational Rapport (e.g. Doesn't seem to read facial expressions or tone of voice adequately and may not realise when other people are upset or angry). The CCC has a reported inter-rater reliability of 0.8 across the scales (range 0.62-0.83) with Cronbach's alpha of 0.867 for one rater and 0.797 for a second (23). The clinical validity of this scale has been shown to be good, using a threshold of 132 or below to indicate pragmatic language impairment. A normative study gave a mean of 153.7 and standard deviation of 6.5 (33).

In addition, we included the verbal and non-verbal scale of the Wechsler Intelligence Scale for Children (WISC) (34) to enable us to judge the impact of pragmatics above and beyond non-verbal performance and more structured language performance. One of the most commonly used measures of its kind, the WISC involves the child performing specific tasks on request and has reported reliability coefficients for the verbal and performance scales of 0.95 and 0.91 respectively.

RESULTS

Descriptive statistics for the key variables together with inter-correlations are provided in Tables 1 and 2. The mean for the CCC pragmatic scale was slightly below that cited in the normative sample (33) suggesting slightly higher levels of difficulty overall. In addition, 82 children (0.6%) of the total sample were identified as having Autism Spectrum Disorders using the methods described above.

TABLES 1 and 2 about here

From Table 2 we can see that from the socio-demographic data that younger age at school entry assessment is minimally related to more disadvantage; birth weight is not associated with any of the other variables, highlighting the diminishing effect of early biological and developmental risk that has been reported elsewhere. As might be expected there was a correlation, low to moderate, amongst the key assessment variables, CCC-Pragmatics, WISC verbal and non-verbal. Gender and social disadvantage were minimally correlated with the key assessments with girls tending to have slightly lower verbal scores ($r_{pbi} = -0.035$, $p = 0.003$) and slightly higher pragmatic ($r_{pbi} = 0.096$, $p < 0.001$) and non-verbal scores ($r_{pbi} = 0.030$, $p < 0.012$) than boys, and those less disadvantaged having greater scores. Perhaps rather surprisingly, being older was associated with poorer scores on the WISC – non-verbal IQ.

1. *Univariable analysis*

In Table 3 all the explanatory variables (age, gender, WISC verbal and non-verbal scales and the CCC) except birth weight are associated with the SDQ Total score outcome. Indeed, for this measure and for all the subscales, birth weight was the only variable not associated with all of the outcomes. a

TABLE 3 about here

In Table 4 we present the multivariable regressions with the total SDQ score and the SDQ subdomains.

TABLE 4 about here

Table 4 shows that in the multivariable model Social Disadvantage and Age are now not associated with any of the behaviour scores, while Gender only retains a significant association with emotional problems and hyperactivity, with girls having more emotional problems and less hyperactivity than boys. Of the key assessments, CCC-pragmatics was still related as before, with the largest impact being on the SDQ total score (-0.319 (CI -0.341, -0.297)). On the one hand the WISC non-verbal scale was no longer associated with the emotional and peer problems, while on the other the WISC – verbal scale only remained associated with Hyperactivity, with higher scores implying less behaviour problems. No differential effect for the genders by Social Disadvantage was found.

2. *Mediation analysis for SDQ Total score*

The mediational analyses investigates the role of pragmatic language in the mechanism by which the greater the social disadvantage, the greater the behaviour problems. In so doing we hypothesise that greater social disadvantage might imply lower pragmatic language skills, which would potentially increase the risk of greater behaviour problems. The pragmatic difficulties could lead to the behaviour problems themselves, poor peer relationships, for example, leading to more friction with the peer group and poor social communication skills aggravating interactions with teachers.

TABLE 5 about here

The results of these analyses, Table 5, reveal that the relationship between social disadvantage and behaviour (SDQ total) was mediated by pragmatic language (partial mediation, 52%). The regression coefficient between social disadvantage and pragmatic language was statistically significant, 0.706 (95% confidence interval 0.486, 0.926), with persons with less social disadvantage exhibiting better pragmatic language; similarly the regression coefficient between pragmatic language and SDQ, -0.319 (-0.340,-0.297), where better pragmatic language scores showed better behaviour. The indirect effect was statistically significant, 0.225 (-0.312, -0.142) but it is also important to note that social

disadvantage influenced behaviour independent of its effect on pragmatic language, -0.205 (-0.338, -0.072).

3. *Mediation analysis for SDQ subscales*

For the SDQ subscores Pragmatics also partially mediates social disadvantage for the SDQ Emotional difficulties, Conduct difficulties, Hyperactivity and Peer Problem subscales, (partial mediation 59%, 37%, 49% and 64% respectively), with the indirect effects being -0.045 ($p<0.001$), -0.044 ($p<0.001$), -0.084 ($p<0.001$) and -0.058 ($p<0.001$) respectively. We can see from Table 5 that for emotional and peer problems subscales, the direct effect is no longer significant but is not quite zero. The SDQ Pro-social mediation analyses are not shown since there was no association with social disadvantage to mediate.

Because of potential concerns about the role played by autism and the SDQ employed as categorical variables we then reviewed these analyses. The multivariable regression and mediational analyses were repeated for those children without a diagnosis of autism as determined by an earlier analysis of the same data set (32). In the case of the SDQ the clinical thresholds used in the original standardisation were employed. This analysis found very similar levels of association to those reported here and in turn would lead to the same conclusions. The analyses were also repeated with behaviour as a categorical outcome and only minor differences were found, in particular, that Age was not significant at the univariable level and in the multivariable analyses social disadvantage was significant. Finally, birth weight as a category (30) was investigated and it did not differ from the uncategorised version in the analyses.

DISCUSSION

The association between social disadvantage and behaviour in adolescence is predictably confirmed and the indirect effect of pragmatics suggests that adolescent behaviour is, at least partially, mediated by pragmatic language skills in middle childhood. Even when adjusting for both verbal and non verbal IQ and gender, pragmatic skills play a major role in mediating the relationship between social disadvantage and adolescent behaviour. Thus, it follows, pragmatic language skills are likely to be a contributory factor in later social and emotional difficulties. More specifically, although this does hold for all children, it appears to be particularly salient for children from more socially disadvantaged backgrounds who also have pragmatic difficulties. It is noteworthy that this is the largest data set of its kind that allows the examination of the relationship of pragmatics in middle childhood with adolescent behaviour.

At one level these results may not appear very surprising given that we know that social disadvantage is likely to be associated with early and potentially persisting language delay and with behaviour problems. But it is the interaction between these factors and specifically the role played by pragmatics which is important here. The same relationship was observed by Ketelars and colleagues (13) in their community sample of 4 year old children. They also found that pragmatic competence, as measured on the same scale (the CCC) predicted behavioural problems independently of social disadvantage and structural language problems. This current study extends this analysis by using a larger data set and by looking at the relationship between pragmatics and behaviour in across time and specifically into adolescence.

The interaction of pragmatic competence with children's emotional and behavioural development and functioning is of interest here. The pragmatic composite score of the CCC consists of 5 scales (scales C to G) covering the domains of: 1) inappropriate initiation; 2) coherence; 3) stereotyped conversation; 4) use of conversational context and 5) conversational rapport. These domains all cover communicative behaviours that are necessary for effective interaction and communication between children and their caregivers, their learning environments and their peers. Given that pragmatic competence was found to mediate partially the relationship between social disadvantage and adolescent behaviour, this suggests that these abilities are necessary preconditions for emotional and

behavioural functioning and development. Without these abilities, children are likely to be at risk of disengaging from those contexts where relating positively to family, peers and professionals is essential.

As discussed above it might be assumed that the relationship between pragmatics and behaviour would best be explained by the fact that children with ASD would, almost by definition, experience both. The fact that the relationship did not change substantively once the 82 children with ASD were excluded suggests that there is not sufficient evidence to support this proposition. There are clearly a great many children with poor pragmatic skills who would not warrant an ASD diagnosis. It is not possible, given both the available data in the cohort concerned and the lack of agreed diagnostic criteria to identify a group of children with pragmatic language impairment but it would be reasonable to assume that a group which would meet the DSM-5 criteria for Social (Pragmatic) Communication Disorder (SPCD) would be in these data and would be affecting the results (35).

There is considerable overlap between the behaviours that constitute pragmatic language skills and those behaviours that are indicative of difficulties in emotional and behavioural functioning (10).

Differentiating between such behaviours is challenging and may reflect different conceptual approaches to understanding children's behaviour. Measuring and quantifying pragmatic language behaviours is a challenge for large cohort studies, which require short and often self or parental report measures rather than in-depth observation carried out by a skilled researcher and/or practitioner. This study measured pragmatic language skills using the CCC and behaviour with the SDQ. These are both parental report measures and the measures may not differentiate robustly between pragmatic language skills and those behaviours indicative of emotional and behavioural functioning. In effect, the scales may be tapping into the same construct.

Implications for practice

There are two major implications of these findings. The first concerns the process of identification and diagnosis, the second relates to the intervention and management of these children. From the relationships described above, it is clear that all children referred to child and adolescent mental health services or to speech and language pathology services ought to have both domains (communication and behaviour) properly assessed (9). The literature indicates that approximately

50% of children referred to mental health or speech and language therapy services will have co-morbid problems and diagnosing on the basis of one or other dimension is likely to lead to misunderstandings and confusion amongst professionals and parents. Whether this constitutes a call for a screening procedure, given the poor sensitivity of most screening tests for development and language development in particular, remains an issue (13). Nevertheless, given the validity and relatively inexpensive nature of both scales, there is a case for both the CCC and the SDQ to be a part of any assessment battery used with children in middle childhood.

Meditational analyses of the type reported here are likely to have implications for intervention because they help identify mechanisms which are potentially important for intervention. Indeed the suggestion has been made that “If we fail to identify mediators, we are likely to make faulty assumptions about the design of improved treatments.” (36). The Cochrane Review of randomised controlled trials of a range of speech and language interventions for children with primary language impairment has demonstrated the potential benefit of such interventions especially with young children and especially for those with speech and expressive language difficulties (37). Clearly it is possible to introduce environmental modifications that can stimulate the development of speech and language skills through a combination of direct instruction and the development of meta-cognitive skills which allow the children to acquire the requisite skills more efficiently. To date the research literature would tend not to support the introduction of social skills training as such, especially in high incidence conditions but social skills and pragmatics are not the same thing. Pragmatics represents a much more closely defined set of behaviours. A recent randomised controlled trial of an intervention to promote pragmatics language skills in the UK targeting children identified with pragmatic language impairment has shown positive outcomes on parent report measures of pragmatic language skills (38). The study involved 87 children with a mean age of eight years randomly allocated to two groups, the first to receive the Social Communication Intervention programme analogous to the treatment for pragmatics and the second treatment as usual. While children’s performance generally improved, the post-test group comparisons were not significantly different for the primary outcome (structural language) but they did reach significance on a number of the secondary outcomes including, at six months post intervention, the pragmatics scale of the CCC. Of course, such findings need to be

replicated but they do suggest that the more social aspects of pragmatic language may be more mutable than those aspects of language which would traditionally be seen as more structural in nature especially towards the latter half of middle childhood. Although behaviour was not an outcome in that study, two-thirds of the children also had considerable behaviour difficulties, suggesting that it would be reasonable to assume that such an intervention would, at least, have the potential to reduce behavioural symptoms given the mechanism described. This begs the question of whether early intervention to promote language skills could have a “knock-on” effect on pragmatics and thus adolescent behaviour. The data in the present study do not allow us to test this but it is possible that this would be the case given the developmental relationship between early structural skills and pragmatics.

Study limitations

Meeting the steps required for mediation does not conclusively establish that mediation has occurred because there may be other models that are consistent with the data. The fact that the targeted behaviours are separated by time increases confidence that the relationship may be directional rather than simply one of association. The mediational analysis presupposes measurement without error and, although the measures used are widely recognised and have been developed for both clinical and research purposes, measurement error is always a risk in such analyses. That such errors are ‘non-differential’ in that they do not lead to biased estimates of the regression coefficients may be a more reasonable contention. As with most longitudinal studies attrition over the time course is an issue and this has to be recognised here with the numbers available for these analyses remaining large, albeit subject to predictable attrition.

CONCLUSIONS

The findings from this study support those of other recent studies highlighting the importance of the role played by pragmatics in the relationship between language skills and behaviour, specifically Conduct problems and Hyperactivity. Indeed in this population and with these measures it appears that pragmatics plays a major role in accounting for some aspects of behaviour. These findings need to be replicated in both comparable and different populations but if the relationship holds then it is

likely to have considerable implications for the development of valid and effective interventions in this area.

ACKNOWLEDGEMENTS

We are grateful to all the families who have taken part in the ALSPAC study, the midwives for their help in recruiting them, and the whole ALSPAC team, which includes interviewers, computer and laboratory technicians, clerical workers, research scientists, volunteers, managers, receptionists and nurses. We would like to thank the ALSPAC speech team who collected the speech and language data and to Laura Miller who has acted as our “data-buddy” throughout this project, providing the dataset promptly and answering our various queries about the variables and coding.

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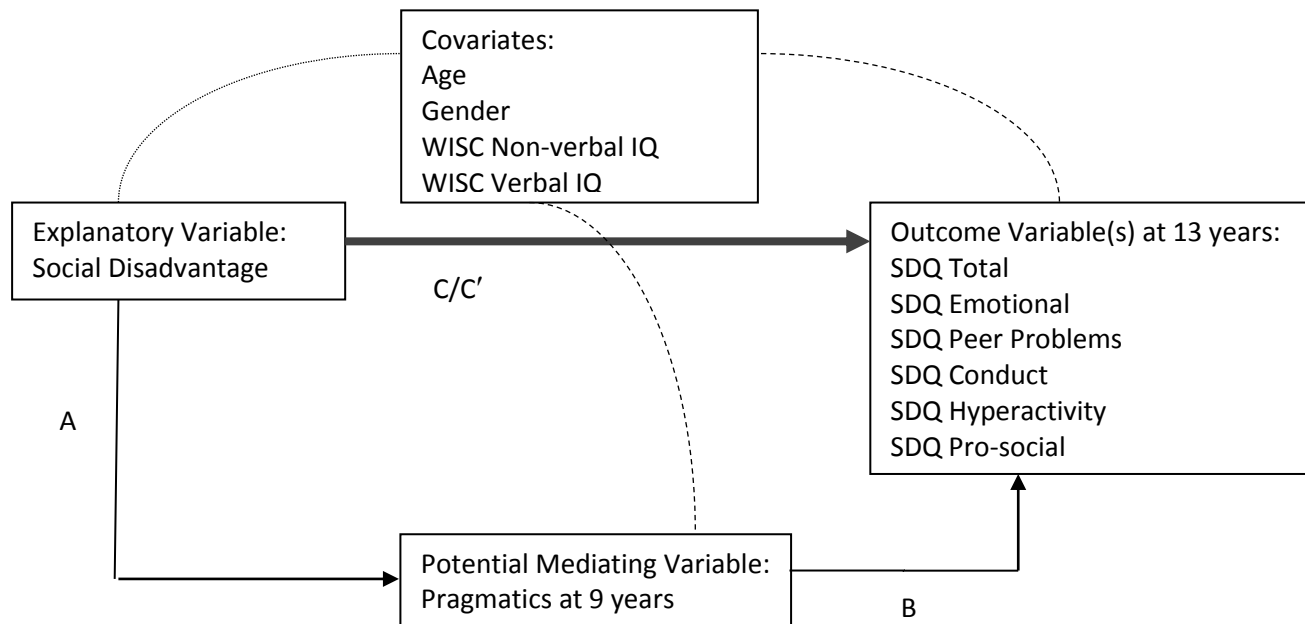
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FIGURE AND TABLES

FIGURE

Figure 1: Pragmatics as a potential mediator of the social disadvantage/behaviour relationship



TABLES**Table 1: Descriptive statistics for all included variables**

	N	Minimum	Maximum	Mean	Standard Deviation
Age (months) at school entry	9645	44	69	54.52	3.753
Birth weight (kg)	13538	0.200	5.640	3.381	0.582
Social disadvantage	11853	0	6	4.259	1.435
CCC – pragmatic language	7240	96	162	150.74	7.992
WISC - verbal IQ	7184	46.00	155.00	107.066	16.8003
WISC – non-verbal IQ	7176	46.00	151.00	99.615	17.112

Table 2 – Correlation matrix for included variables (Pearson's r)

	Gender	Age at school entry	Birth weight	Social disadvantage	CCC - Pragmatics	WISC - Verbal IQ
Age (months) at school entry	-.012					
Birth weight	-.003	.001				
Social disadvantage	.003	.026*	.007			
CCC – pragmatic language	.096**	-.002	-.003	.217**		
WISC - verbal IQ	-.035**	-.004	.003	.351**	.248**	
WISC - non-verbal IQ	.030*	-.029*	.007	.237**	.201**	.500**

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 3 Univariable regression models with behaviour (SDQ Total score and subdomains) as the outcome variable

	SDQ Total	Emotional problems	Conduct problems	Hyperactivity	Peer problems
	Coefficient (95% CI)	Coefficient (95% CI)	Coefficient (95% CI)	Coefficient (95% CI)	Coefficient (95% CI)
Gender (1 Male/2 Female)	-0.720*** (-0.955,-0.484)	0.399*** (0.319, 0.480)	-0.075* (-0.143, -0.008)	-0.820*** (-0.923, -0.716)	-0.236*** (-0.312, -0.160)
Age (months) at school entry	-0.056** (-0.095,-0.017)	-0.014 (-0.027, 0.000)	0 (-0.011, 0.12)	-0.028** (-0.045, -0.010)	-0.016* (-0.028, -0.003)
Birth weight	-0.062 (-0.275,0.152)	-0.017 (0.090, 0.057)	-0.028 (-0.089, 0.034)	-0.018 (-0.113, 0.077)	-0.009 (-0.078, 0.061)
Social disadvantage	-0.728*** (-0.822,-0.634)	-0.135*** (-0.167, -0.102)	-0.161*** (-0.188, -0.134)	-0.301*** (-0.343, -0.259)	-0.148*** (-0.179, -0.117)
CCC – pragmatic language	-0.331*** (-0.345,-0.316)	-0.063*** (-0.068, -0.057)	-0.058*** (-0.063, -0.054)	-0.131*** (-0.137, -0.124)	-0.080*** (-0.085, -0.075)
WISC – verbal IQ	-0.057*** (-0.065, -0.049)	-0.011*** (-0.013, -0.008)	-0.009*** (-0.012, -0.007)	-0.029*** (-0.032, -0.025)	-0.008*** (-0.011, -0.006)
WISC – non-verbal IQ	-0.053***	-0.009***	-0.01***	-0.026***	-0.008***

	(-0.061, -0.046)	(-0.012, -0.007)	(-0.012, -0.007)	(-0.03, -0.023)	(-0.011, -0.006)
Birthweight <1500	0.294	0.077	0.087	0.167	-0.056
	(-0.935, 1.522)	(-0.346, 0.501)	(-0.267, 0.44)	(-0.38, 0.714)	(-0.456, 0.343)
***p<0.001, **p<0.01, *p<0.05					

Table 4: Multivariable regressions for all SDQ domains, with gender and social disadvantage interaction(*)

	SDQ Total	Emotional problems	Conduct problems	Hyperactivity	Peer problems
	Coefficient (95% CI)	Coefficient (95% CI)	Coefficient (95% CI)	Coefficient (95% CI)	Coefficient (95% CI)
Gender (1 Male/2 Female)	-0.183 (-1.375,1.01)	0.598* (0.132,1.064)	-0.104 (-0.479,0.27)	-0.583* (-1.129,-0.036)	-0.189 (-0.601,0.223)
Age (months) at school entry	-0.023 (-0.064,0.018)	-0.005 (-0.021,0.011)	0.004 (-0.009,0.017)	-0.015 (-0.034,0.003)	-0.009 (-0.023,0.005)
Social disadvantage	-0.198 (-0.601,0.205)	0.001 (-0.157,0.158)	-0.121 (-0.248,0.005)	-0.074 (-0.259,0.111)	-0.054 (-0.193,0.085)
CCC – pragmatic language	-0.319*** (-0.341,-0.297)	-0.061*** (-0.07,-0.053)	-0.062*** (-0.069,-0.055)	-0.118*** (-0.128,-0.107)	-0.079*** (-0.087,-0.071)
WISC – verbal IQ	-0.003 (-0.014,0.008)	0.002 (-0.003,0.006)	0.003 (-0.001,0.006)	-0.009** (-0.014,-0.004)	0.002 (-0.001,0.006)
WISC – non-verbal IQ	-0.017**	-0.004	-0.004*	-0.009***	-0.001

	(-0.027,-0.007)	(-0.008,0.001)	(-0.007,0)	(-0.013,-0.004)	(-0.005,0.002)
Gender*Social	-0.005	-0.021	0.031	-0.009	0.014
disadvantage	(-0.254,0.245)	(-0.118,0.077)	(-0.048,0.109)	(-0.124,0.105)	(-0.072,0.101)
***p<0.001, **p<0.01, *p<0.05					

Table 5: The mediational effect of pragmatics on the relationship between social disadvantage and the SDQ subscales, adjusted for IQ, age and gender

Outcome		SDQ Total	Emotional problems	Conduct problems	Hyperactivity	Peer problems
Step	Path	Coefficient (95% CI)	Coefficient (95% CI)	Coefficient (95% CI)	Coefficient (95% CI)	Coefficient (95% CI)
1	C Total effect	-0.430*** (-0.579,-0.280)	-0.076** (-0.129,-0.023)	-0.119*** (-0.162,-0.075)	-0.172*** (-0.237,-0.106)	-0.090*** (-0.139,-0.041)
2	A	0.706*** (0.486,0.926)	0.729*** (0.509,0.949)	0.718*** (0.499,0.937)	0.710*** (0.491,0.929)	0.737*** (0.518,0.957)
3	B	-0.319*** (-0.340,-0.297)	-0.061*** (-0.069,-0.053)	-0.062*** (-0.068,-0.055)	-0.118*** (-0.128,-0.108)	-0.079*** (-0.087,-0.071)
4	C□ Direct effect	-0.205** (-0.338,-0.072)	-0.031 (-0.084,0.022)	-0.075** (-0.116,-0.033)	-0.088** (-0.149,-0.027)	-0.032 (-0.078,0.014)
WISC - verbal IQ		-0.003 (-0.014,0.008)	0.002 (-0.002,0.006)	0.003 (-0.001,0.006)	-0.009** (-0.014,-0.004)	0.002 (-0.001,0.006)

WISC - non-verbal IQ		-0.017** (-0.027,-0.007)	-0.004 (-0.008,0.000)	-0.004* (-0.007,-0.000)	-0.009*** (-0.013,-0.004)	-0.001 (-0.005,0.002)
Age (months) at school entry		-0.023 (-0.064,0.018)	-0.005 (-0.021,0.011)	0.004 (-0.009,0.017)	-0.015 (-0.034,0.004)	-0.009 (-0.023,0.005)
Gender (1 Male/2 Female)		-0.204 (-0.508,0.101)	0.501*** (0.381,0.621)	0.037 (-0.059,0.133)	-0.626*** (-0.766,-0.485)	-0.123* (-0.229,-0.017)
Mediation (%)		0.52	0.59	0.37	0.49	0.64
	R²	0.261	0.087	0.116	0.232	0.142
	sample size	2915	2923	2923	2924	2921
***p<0.001, **p<0.01, *p<0.05						